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Basement Construction

From the Editor . . .

As I reflect on my high school days, I marvel at the changes that have happened in a short period of time. Since I finished school, we have seen the advent of technologies we never even dreamed of in school – at best they were the stuff of science fiction. Man has even walked on the moon, but we've largely forgotten about that triumph of human ingenuity and imagination.

Someone much wiser than me once made a comment to the effect that we forget history at our peril. This saying came to mind as I have been observing recent events we are witness to – the greed among the supposedly intelligent bankers that have bankrupted the US, the meaningless and tragic wars being waged in the name of unknown goals, and even the nonsense that is passing for a serious democratic debate in our election campaign.

We are living in an age where anything more than 3 or 4 years old is considered a historical artefact. Ten or 15 years is an eternity. In the Internet age, attention spans more than a few minutes seem to be the exception. Education has been dumbed down to the basics. There is more focus on reading and 'rithmetic but little allowance for the creative imagination that enriches the mind and has a value beyond simple bean counting.

Topics such as history, philosophy, music and art are fast disappearing from schools. School libraries are being starved of resources, if not closed down entirely. But the Internet is not a substitute for historical documents and books. History is not just the study of dates and boring old men who battled each other, but also deals with broader issues.

The lack of understanding of the value of history at all levels will come back to haunt us. It is not just something of interest to a few pointy-headed academics. All of human knowledge is evolutionary, built on the foundations of discoveries by previous generations. The Internet and all its technology may be wonderful, but at the end of the day it is not much more than a more sophisticated toolbox with fancy pencils and filing cabinets. It is the content that gives it meaning and value, and the content is not generated by the geeks in Silicon Valley, but by countless users.

So what does all of this have to do with the building industry you wonder? The change in the demographic make-up of society means we are seeing an aging population. Perhaps more significantly, we are seeing a new generation taking over. At the same time we are seeing a loss of 'corporate' memory. For the industry, it means a memory of how and why current practices, standards, and codes or at least certain provisions within them were crafted. Some may still need fixing, others are a result of past experiences.

As we move through life, we have many experiences, not always fully documented, yet extremely important to what we do. That knowledge often, but not always, gets passed on. Knowledge of good and bad experiences is valuable. Having some historical knowledge can help us to progress and avoid prior mistakes.

With the aging population, and the lack of appreciation of our history, we are doomed to repeat past mistakes unnecessarily. Stupid wars and economic upheavals can be avoided, or at least minimized, if we pay some attention and learn lessons from the past. So too we can learn from past successes and mistakes our forebearers made.

Some very fine old buildings have stood through time because they were crafted by craftsmen who took their time and understood in some way how things were supposed to work. There never was a one size fits all type of approach – buildings in different regions followed different details because local conditions differed.

I am starting to hear stories about newcomers in positions of authority who don't understand some of these fundamentals, and are trying to impose solutions that have proven not to work. If we are not careful, we will see a repetition of past mistakes. As the saying goes, we forget history at our peril.

Richard Kadulski,
Editor

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Basement Construction

Foundations for houses traditionally have received much less attention than they should, yet basements are a major source of problems. Basements in older homes were often damp and poorly lit, accommodating the heating equipment, fuel and providing storage for fruits and vegetables.

Poor foundation performance has been tolerated because even a leaky, damp basement will seldom result in destruction of the building. It may be a source of excessive heat loss and indoor air quality problems that in the long run will affect the occupants, but are often tolerated simply because that has been the normal condition in housing for years.

Most building designs used in Canadian house construction have evolved into current practice through improvements based on trial and error. When a particular construction system and its materials become recognized (often identified by a reduction in the overall cost of construction, including cost of 'errors' or call-backs) the approach becomes mainstream practice in a given area.

Today, most basement interiors are being finished, or at least there is an expectation that at some point they will be finished. Increasingly the basement is being finished for recreation rooms, home offices, workshops and even extra bedrooms.

In most cases it is just as easy to provide a proper foundation that is warm and dry as it is to build a poor one. However, regardless of how the basement is finished, it is essential that the basement be kept dry if it is to serve as useful living space. Achieving this requires more attention to the design and detailing of the foundation.

The basement can be a challenging environment in which to build liveable space. By its very nature, it is the lowest location in the house, and often the coolest, most humid space. The basement is surrounded by soil which can be dry, moist, wet or frozen, and sometimes all of these at the same time. Conditions will vary from site to site, even within the same block. As a result, the envelope components are subjected to greater structural, water and moisture loads than the above-grade portions of the building.

Although the above-grade components are subjected to more extreme thermal loads, the duration of the below-grade heating season can be longer and is out of phase with the rest of the house and the outdoors. Inside, the basement is often allowed to run cold and damp, especially if it is not used regularly and the construction assemblies themselves can be separated from the interior air by storage boxes, cold storage spaces, etc.

With the greater use of insulated basement walls below grade, moisture problems, especially moisture seepage through the walls, have been noted recently. High moisture levels can cause structural problems as well as lead to mould and mildew growth, which are potential health risks. In some locations, difficult soil conditions have been the cause of major problems that have entailed costly repair.

Site Assessment

The characteristics of the site will define the most appropriate construction details. The most obvious questions to ask are where is the groundwater table, and whether or not the site is subject to flooding or large-scale earth movements. Flood risk might be considered too obvious for special consideration yet we still see large developments in flood plains protected behind dikes and in high water table areas. The impact of climate change has not yet been fully implemented into the planning process, but it will have

Basement Systems and Material Selection

Selection of basement systems and materials at the design stage involves the following process:

- Understand the building physics.
- Identify the environmental constraints.
- Select the appropriate basement system.
- Review all functions expected of the system and identify the roles that materials have to play within that system.
- Select the appropriate materials to satisfy the needs of the system.
- Review both the envelope system and the materials for durability criteria.
- Review the material Evaluation Reports and applicable Codes & Standards to ensure that compliance is achieved.
- Review the initial material and labour costs, cost of operation, maintenance and repair, and weight as appropriate for builder, client and societal needs.
- Refine the design as needed.
- Set up and follow a quality assurance program to ensure that the product meets the specs and the expectations.

catastrophic impacts on the infrastructure needed to protect homes in low-lying areas.

Soil creep down natural slopes and stream banks is a common phenomenon in many regions. The edge of any large slope should be avoided as a building site unless detailed geotechnical investigation proves it to be stable.

Another extremely important consideration is the drainage of the site. Surface water must be removed either by natural drainage or by the provision of an artificial drainage system. The ground water around basement walls must be collected in subsurface drains and removed from the site. The function of perimeter drain tiles is essentially to lower the ground water level at the house.

If the water table is near the surface, then the site is not appropriate for deep in-ground basements. Special attention must be paid to seasonal influences on groundwater table. A low water table during a dry season will not necessarily be the case during other times of the year.

Waterproofing the Basement

The best way to waterproof a basement will depend on the soil conditions, groundwater level and the drainage of the property. It is important to remember that the damp proofing that is applied to concrete does not provide waterproofing protection. Damp proofing fills in the pores in the concrete to reduce the absorption of groundwater into the concrete. The damp proofing is a capillary break. Depending on the conditions in the soil, the damp proofing materials themselves may deteriorate over several years due to microbial action.

The most severe conditions occur in low-lying areas where the groundwater level is near the surface, and the soil is coarse grained. Water will move freely through such soil so that it will be impossible to lower the water table adjacent to the basement walls.

In high water table areas, and areas subject to flooding, basements should not be built.

A fine grained soil will restrict the movement of water and a dry basement may be achieved, provided the water table is lowered by means of drain tile located at or below the footings to catch and carry water away from the building.

However, it must be noted that in reality, soil is rarely dry so will always be a reservoir for moisture into the house and that moisture will be

Functions of the basement envelope system.

Performance Related

- Provide structural support
- Provide earth retention
- Control heat flow
- Control air leakage including soil gas
- Control surface emissions
- Control surface condensation
- Control interstitial condensation
- Control moisture flow into the envelope from the interior
- Control moisture flow into the envelope from the exterior
- Control embodied moisture
- Control rainwater, snowmelt and ground water
- Control sewer water
- Control light, solar and other radiation
- Control noise
- Control fire
- Be durable (i.e. provide the above functions without premature failure over the service life of the envelope)

Construction Related

- Be economical
- Be buildable in a timely fashion, with available labour and materials
- Be resistant to the rigours of the construction process, including weather, site storage and handling
- Accommodate services - electrical, plumbing, HVAC, etc.

Market Related

- Provide market value by
- Being aesthetically pleasing
- Creating usable and liveable space
- Providing serviceable finishes (e.g., flat, cleanable, and supportive of furnishings and contents)

taken up by the concrete, unless the concrete is isolated from contact with water.

If absolutely necessary, there are techniques by which the walls and floors of a basement can be waterproofed to resist the hydrostatic pressure of several feet of water. This is sometimes done in large commercial buildings, but should not be necessary in houses, and should be avoided.

Good practice in basement construction requires a footing drain tile, set lower than the base of the footing to remove subsurface water from the site, a moisture barrier (at least 6 ml polyethylene), granular fill under the floor slab and over the tile and a drainage material applied on the exterior of the basement walls. The footing should also be wrapped with a waterproof membrane to reduce soil moisture being wicked inside through the concrete.

One basement detail that rarely gets considered is the detail for the foundation footings. Footings sit on hardpan, which means that frequently they are sitting in standing water. The water can be absorbed into the foundation by capillary suction through the footings. This is referred to as rising damp and can be a major source of moisture in the building. Unfortunately, rising damp is usually ignored.

Interior Basement Finishes

There are many ways to finish the inside of a basement. In the past, the simplest was to simply paint the concrete or masonry wall surface – there are few moisture problems this way but there is no insulation value in the paint film. Generally, walls are finished with materials such as plywood, fiber-board or gypsum board applied to furring. Insulation is added to reduce the heat loss, and increasingly, insulation levels are going up. These kinds of finishes create rather complex problems in regard to moisture control.

Unlike other walls, the conditions on a basement wall vary from top to bottom. The above grade portion must meet the same requirements as any exterior wall exposed to the weather. The portion of the basement wall below grade is, however, subjected to very different conditions and the design of the wall must be changed.

In the lower part of the wall, moisture from the damp earth must be considered. In the past, when the interior surface of the wall was largely unfinished, any moisture passing through the wall simply evaporated into the air in the basement. The efflorescence (the white crystals resembling fungus growth on the concrete) was one indication of moisture movement through the wall and evaporating from the surface, although this process may at times leave no traces.

If a finish is applied over the surface of the wall below grade then moisture cannot readily evaporate and the wall may become damp. Especially when polyethylene vapour barriers are used in the basement, the moisture may build up to the point that wood members start to rot. The interior insulation and finishing approaches must take into account the moisture in the concrete that migrates through the concrete and up through the footing.

The first step in finishing the wall is to provide a moisture barrier that extends from grade level down to the base of the footing. A number of proprietary products – dimpled sheets and filter cloth-covered mats are being used to create a capillary break against the wall. These are below grade counterparts to the rain screen cavity in above ground walls. Coarse, free draining backfill will also perform the same function.

Insulation of a basement is required by most building codes and should be done even when no significant finishing of the basement is contemplated. The heat loss through the upper portion of an uninsulated wall can be many times that of the average well-insulated wall, so the cost will be recovered in fuel saving within a few years.

In the past, the minimum requirement was for insulation to be applied to the upper part of the wall only – typically the top 2 ft below grade. The assumption was that below this level the earth against the outside of the wall provides insulation. However, we now better understand heat flow dynamics, and recognize that although the heat flow is reduced, there still is a need for below ground insulation. The soil temperatures are always lower than the interior temperature, so there will be a constant temperature gradient, and heat flow, from the interior to the exterior, which can be reduced by insulating the assembly.

Basements can be insulated on the interior or the exterior. Exterior insulation has the advantage of warming the wall so that condensation

cannot occur on the wall and the wall can dry to both the interior and the exterior. Installation of exterior insulation does present some technical difficulties because it must be protected from damage during back filling around the foundation, from ultraviolet exposure, and mechanical damage by homeowners. It can be done successfully but requires some planning and effort.

When detailing the foundation wall systems, it is important to understand the direction in which drying will occur. In the heating season the drying is mostly to the exterior, while in the cooling season (in those climates where there is a need for summer cooling) the drying is mostly to the interior. Interior insulation must be airtight to prevent warm, moist interior air from condensing on the cold concrete foundation wall, but it should be semi-permeable to permit moisture drying into the basement.

The basement is damp-proofed on the exterior, thus reducing the drying potential to the exterior. The solution is to use insulating materials that are permeable or semi-permeable such as unfaced extruded polystyrene (EPS) or extruded polystyrene (XPS) foam insulation as well as spray-in-place foam insulation. These materials are also not sensitive to moisture.

The building code requirement for a vapour barrier sets a permeability limit of 60 ng/Pa-s-m^2, which is sufficiently permeable to protect the finishes and to permit the drying of capillary water to the interior at a rate that does not damage interior finishes or lead to mould. By comparison, polyethylene has a permeability of only 3-6 60 ng/Pa-s-m^2, which is why one often sees the build-up of moisture on the backside of poly in an insulated basement – that moisture simply is not able to dissipate into the house.

That is why the vapour barrier function on basement walls is best met with a more permeable material, such as 'vapour barrier' paint on the drywall. If 2 inches or more of polyurethane spray (2-pound) foam insulation is applied onto the concrete wall, the spray foam itself will be the vapour barrier.☼

Basement Construction Points to Remember

Performance expectations for environmental separation have become more demanding as basements are used as living space.

The Building Code only sets out minimum requirements. It can't anticipate all the variations in conditions where a basement will be placed, so considerable decisionmaking and responsibility is left to the designer/builder.

The tools available for decision making are: builders' experience, builders' guides, material standards and application standards, evaluation guides, engineering manuals, and engineering/architectural services from consultants and municipal offices.

When building a basement, make sure that all the functional requirements expected of the building envelope are met by the materials or systems used, and that all the materials together provide satisfactory performance – in other words, remember that the 'basement-is-a-system.'

There are many different ways to build a basement. All should be able to function as intended when the environmental conditions on the site are taken into account.

Builders, designers and inspectors must all understand the intended function of the materials and systems to be used to ensure that the assembly techniques don't defeat the intended properties or function of the materials and systems.

There is a balance between first cost of construction, cost of repair (including warranty work), and cost of maintenance and operation. That balance changes with conditions, and must be considered on a site-by-site basis.

Performance Guidelines for Basement Envelope Systems and Materials Final Research Report by Michael C. Swinton, IRC/NRC and Dr. Ted Kesik, University of Toronto

These guidelines were developed by the National Research Council of Canada (NRC) under the guidance and review of a Steering Committee formed by representatives of industry associations and government agencies to promote better performance in basement construction. The document is available for download at the IRC website:

http://irc.nrc-cnrc.gc.ca

Good Basement Detailing

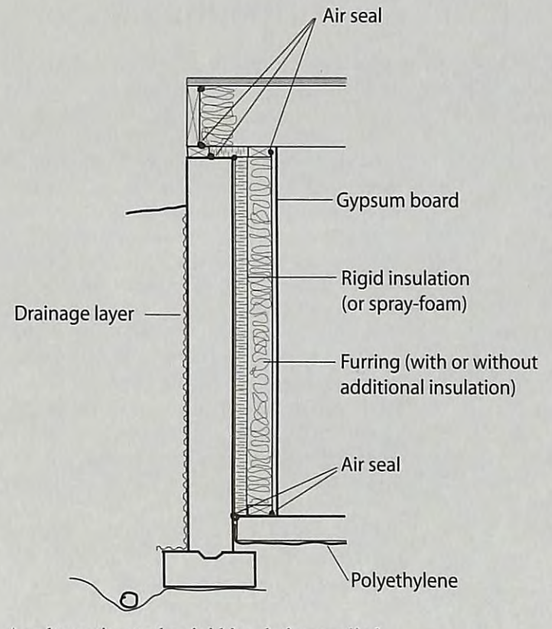
Water vapour movement by diffusion always moves from more to less - from a wetter to a dryer area. The vapour retarder should be on the moist side (i.e., area with the higher vapour pressure) to control vapour diffusion.

Since soil is wet most of the time (at 100% relative humidity), the vapour drive is almost always inward across the entire foundation wall except near the top of the basement wall during winter in humid houses. Moisture moving by diffusion from the drying concrete and soil is trapped by the interior vapour barriers.

Water vapour also moves with airflow, from an area of high pressure to low pressure. To control moisture movement by air leakage, it is important to stop airflow. This requires a good air barrier, as well as avoiding air loops within the insulated assemblies.

Common problems in basement walls are the air spaces within a furred wall which are caused by the way insulation is installed. Unless the insulation is a blown-in material, or fibrous batts are perfectly installed to leave no voids, there will gaps in the insulation around the furring on both sides of the batt. These airspaces allow air currents to develop because the temperature difference between the warm and cold side of the insulation. Warm air will rise in the interior channels drawing cold air down against the concrete so that convection currents are generated by stack action within the wall. Because of the constant cool temperatures in the ground, these convention currents in the basement walls can be significant - both in summer and winter. At various times the air will encounter surfaces that are below the dew point temperature, leading to condensation and moisture build up within the wall.

A better way to build a basement wall is to install rigid insulation, such as expanded polystyrene insulation directly to the concrete. Furring for interior finishes would be placed inside of the rigid insulation, which could also have additional insulation. The interior drywall finish would be applied directly over the furring, with careful attention to sealing all joints and connections to ensure an airtight assembly. No polyethylene vapour barrier should be used here, but a vapour barrier paint. (see detail)



An alternative to the rigid insulation applied to the interior of the foundation wall would be to use a vapour permeable spray-in-place foam insulation (a half-pound foam such as Icynene, Enertite or Demilec). This offers a well insulated, airtight but somewhat vapour permeable assembly that is able to deal with the small amount of seasonal water vapour movement. ☼

CertainTeed MemBrain™ Smart Vapour Retarder

MemBrain™ is a vapour retarder intended for use with unfaced, vapour permeable insulation (fiber glass and mineral wool) in wall and ceiling cavities. It is a polyamide film that changes its permeability with the ambient humidity condition. The product's permeance is less than 1 perm (60 ng/Pa-s-m^2) when tested in accordance with ASTM E 96, dry cup method, and increases to more than 10 perms using the wet cup method. This variability allows for drying, and prevents the build up moisture.

When the relative humidity increases above 60%, the pores in the material expand and its permeability increases, allowing drying of the assembly to occur, in either direction, by vapour diffusion, thus decreasing moisture accumulation within the construction and potential moisture damage.

This product can be used in place of traditional vapour retarders. It is not suitable for locations with constant high humidity.

CCMC Evaluation Report 13278-R
More information: *www.certainteed.com*

Location of Low Permeance Materials

There is a Difference Between an Air Barrier and Vapour Barrier

In order to build a durable building, we need to be able to manage moisture. Bulk water – in forms such as rain, snow, sleet or hail is understood. It is obvious and visible. Moisture in the form of vapour is less obvious and more difficult one for many to grasp, and a source of much confusion. It can also be a significant contributor to building failures.

Air movement and vapour diffusion are the key mechanisms that need to be understood and dealt with in order to build a durable building. Of the two mechanisms, control of air movement is by far the most important. Air movement moves much more moisture than diffusion. That is why it is important to make the building envelope airtight.

Conceptually, it is easy to understand how to make a building airtight, since many materials used alone or in combination, when properly caulked and sealed, can create an airtight building envelope.

Moisture movement by vapour diffusion is more subtle and more misunderstood. Moisture flow by diffusion is water molecules in the air that move through a material from an area with high moisture concentration to a drier area, or from warm to cold. Depending on the conditions, vapour flow can be from inside out or outside in. Generally, in Canada the vapour drive is from inside to outside.

Today, we use a variety of wall assemblies and new materials with multiple layers of materials. Alarms are raised when low permeance materials, such as extruded polystyrene or polyurethane spray foam, are used near the exterior face of walls. The concern is that the low permeability material, such as foam sheathing, could be the same as putting a vapour barrier on the cold side of the wall where it might be below the dew point and thus lead to condensation and deterioration of building materials.

New construction practices and materials used today increase the building's airtightness, but at the same time, there are concerns that condensation or moisture problems can result if the wrong materials are used in the wrong location or not at all. However, there still is also a lot of confusion about the difference between air barriers and vapour barriers.

By keeping the wall warm, foam sheathing actually reduces the chance of condensation within the wall.

Since the 1970s we have become accustomed (aided by code requirements) to rely on polyethylene as the air and vapour barrier (which is the code term for a vapour diffusion retarder) even though **the codes do not insist on the use of polyethylene**. The over reliance on polyethylene has even on occasion led to moiture problems. However, it is important to recognize that diffusion moves miniscule quantities of moisture, so vapour diffusion retarders are not as critical in most cases as barriers to air movement, but if moisture movement by diffusion is trapped within an assembly, moisture levels build up to dangerous levels.

The Building Code (9.25.1.2) requires that a vapour barrier (a low vapour permeance material) must be installed on the warm face or within the assembly at a position where its inner surface is likely to be above the dew point – warm enough for most of the heating season so no significant moisture accumulation will occur. The code defines a vapour barrier as a material with a permeability no greater than 60 ng/Pa-s-m^2.

The vapour barrier does not have to be on the interior face of the wall. The Building Code recognizes that the vapour barrier can be placed part way into the wall. The location of the dew point can be calculated or defined by the ratio of the insulation R-values outboard and inboard of the innermost impermeable surface of the material in question. The allowable ratio of inboard/outboard insulation is related to the severity of the climate, and is laid out in Table 9.25.1.2 of the Building Code. The assumptions for the table include a balanced mechanical ventilation system, a 60 ng/Pa-s-m^2 vapour barrier and an air barrier (airtightness between 0.024 and 0.1 L/sm^2).

As long as the interior face of the low permeability material is above the dew point, there will be no condensation.

In most of Canada, winter indoor relative humidity is limited by the exterior temperature and the corresponding temperature on the inside of windows. During extremely cold periods, indoor RH will rarely be higher than 35% as condensation on windows (the coldest surfaces) takes place and in effect dehumidifies the house. When this happens, occupants are likely to increase the ventilation to remove excess moisture. In milder climate locations, the condensation will happen at a higher RH.

Ratio of Outboard to Inboard Termal Resistance
(from Table 9.25.1.2)

Degree-Days (°C)		Minimum insulation ratio
< 4,999	Vancouver, Kelowna, Ottawa, Toronto, Montreal, Fredericton, Halifax, St. John's NL	0.20
5,000 - 5,999	Prince George, Calgary, Edmonton, Regina, Winnipeg, North Bay, Quebec City	0.30
6,000 – 6,999	Ft. McMurray, Whitehorse	0.35
8,000 – 8,5000	Yellowknife	0.5
10,000 – 10,999	Iqaluit	0.6

Typical assembly	Insulation ratio
2x6, drywall interior, R-20 batt, R-5 Extruded polystyrene sheathing insulation	0.28
2x6, drywall interior, R-20 batt, R-7.5 Extruded polystyrene sheathing insulation	0.40
2x6, drywall interior, R-20 batt, R-10 Extruded polystyrene sheathing insulation	0.53

Assemblies built within the criteria of the code table have been shown to not lead to moisture accumulation levels that may lead to deterioration as long as the average vapour pressure difference between inside and outside does not increase significantly.

Most analysis is done with a static single point analysis. These analyses do not take into account that most construction materials are able to safely absorb a certain amount of moisture, so in effect those materials also provide a buffer. As long as drying can take place, the moisture content may fluctuate, but as long as it does not build up and exceed the moisture capacity before drying can take place, there will be no damage.

It is only when the indoor environment has extremely high humidity levels, such as in an indoor swimming pool, a spa or plant-filled sunroom (or grow-op!), or in extreme climatic conditions, that it would add more stress to the building envelope. Otherwise, concerns about placement of the vapour barrier are not as important as many think. By keeping the walls warm, foam sheathing actually reduces the chance of condensation within a wall.

There are other ways of providing airtight construction assemblies that don't rely on polyethylene. They offer durable, even better options, especially if one wants a 'breathable' wall (which itself is a misnomer, as the 'breathability' is really a reference to the drying potential of a wall assembly and not the air movement).

A 'breathable' wall allows miniscule amounts of moisture (in the form of water vapour), driven by the vapour pressure differential between inside and outside, to pass through, thus preventing the build-up of moisture at the face of the impermeable material. It is the difference between a permeability of 3-4 ng/Pa-s-m^2 of poly, which has no drying potential, and 50 or 60 ng/Pa-s-m^2 of foam insulation, or 30-40 ng/Pa-s-m^2 of a low perm paint finish on drywall. These latter would allow some drying to take place, and prevent moisture build-up. That is why polyethylene, instead of a more permeable vapour diffusion retarder, on a basement wall is a poor detail.☼

Most construction materials can safely absorb some moisture, so thus they provide a buffer. As long as drying can take place, the moisture content may fluctuate, and there should be no damage.

Canadian Home Builders' Association

Technical Research Committee News

Public Review of Proposed National Building Code Changes

The next revision of the National Building Code is due in 2010. Proposed changes will be available September 28 for two months. Proposed changes can be viewed online at the Codes Centre site, *www.nationalcodes.ca*. Follow the links to Public Reviews. The package of changes is being reviewed at the same time by the provincial regulators, so that when the next edition of the Code is ready, its adoption by local jurisdictions should be fairly quick.

Although most of the proposed changes are considered minor housekeeping changes, a number of proposed changes in Part 9 (Houses and Small Buildings) will be of interest to the housing industry. These include:

New **lateral load requirements** for buildings in high-risk areas, and new bracing and nailing requirements in medium-risk zones. Since this primarily affects the seismically active regions of British Columbia, it is getting special attention in BC. A 'test-run' of the proposed changes is being done by a builder on Vancouver Island to assess the cost impact, practicality and ease of use of the proposed changes.

Requirements for **windows, doors and skylights** will be reorganized and a new system of classifying windows adopted to reflect changes in the windows standards.

Changes to text of the clauses dealing with **air and vapour barriers** to clarify where in the building envelope low air- and vapour-permeance materials may be located. Based on a review of the conditions in buildings, and the associated moisture and airflows, the relative humidity constraints on low permeance materials will change to simply refer to "normal conditions". The proposed code language changes should simplify the application of alternate vapour barrier systems.

Proposed Code changes are still being developed for dealing with **radon** and will be dealt with later but still in time for the 2010 Code. However, there will not be a reference to radon testing requirements in Part B. An appendix note will reference the new Health Canada guidelines of a maximum acceptable level of 200 Bq/m^3.

Changes are being proposed to requirements for **limiting distances**. These originated in Alberta where it has been identified that the original code requirements for allowable openings in side yards did not reflect changes to new house designs and smaller lot conditions seen today, which compromise fire safety.

A proposal to define **secondary suites** and set standards which are different from standard duplex dwellings.

Health Canada Radon Guidelines

Radon is a radioactive gas found naturally in the environment. It is produced by the decay of uranium found in soil, rock or water. It is invisible, odourless and tasteless, but emits ionizing radiation that can cause cancer. Because radon is a gas, it can move freely through the soil enabling it to escape to the atmosphere or seep into buildings.

Long-term exposure to high levels of radon increases the risk of developing lung cancer. It is estimated that about 10% of all lung cancers worldwide are related to radon exposure. The magnitude of the risk depends on the amount of radon present, the length of exposure, and whether or not the occupant smokes. The combination of inhaling radon gas and smoking can significantly increase the risk of lung cancer.

Health Canada is planning to launch a public outreach campaign to address the new radon guidelines, and what homeowners should do to determine if it is an issue in their house.

Renovators especially should be aware of this issue.

Objective-Based Codes: Introduction to Their Use

A key principle of the 2005 National Building Code is that the requirements are based on four fundamental objectives: Safety, Health, Accessibility, and Fire and Structural Protection of Buildings.

Part B of the Building Code is lengthy and contains acceptable solutions. This is the portion most users of the building code use on a day-to-day basis. However, it is Part A that sets out the objectives of the code, which in theory should make it easier to assess alternate solutions that are not explicitly spelled out in Part B. Unfortunately, the complexity of documenting an alternate solution means that some building authorities and code users have a difficult time dealing with this option.

Because the building code is a provincial responsibility, and the National Building Code is simply a model code that provinces adopt, the Canadian Codes Centre is not able to provide training on how to use the Code. However, they have developed a package that provides an introduction to objective-based codes. It is a self-learning basic awareness course designed to help Code users understand the new objective-based approach of the 2005 NBC.

The seven modules of the course briefly, yet thoroughly explain the new terminology and concepts of the objective-based approach, supported by examples using Code provisions. A summary at the end of each module can serve as a quick reference for future use.

- Module 1 Introduction to the Course
- Module 2 Organization of the 2005 Code
- Module 3 Applying the Code Using Division B
- Module 4 Intent Statements
- Module 5 Application Statements
- Module 6 History of Objective-Based Codes
- Module 7 Introduction to Alternative Solutions

The course is available online at the Codes Centre site, *www.nationalcodes.ca*. Follow the links to the National Building Code.

US Residential Sprinkler Regulations

The US International Code Council, which develops the ICC model code that is the model document for building codes in 46 US states approved changes to the code making fire sprinklers in new one-family and two-family homes mandatory. The lobby group that pushed the changes will now be moving to lobby state and local authorities to adopt the new code requirement.

Similar lobbying efforts are made in Canada, but convincing documentation has yet to be provided to justify making sprinklers mandatory in all new houses in Canada. ☼

Canadian Geoexchange Coalition Warns Of Contractor Misrepresentation

The Canadian GeoExchange Coalition (CGC), Canada's industry association for ground-source heat pump technology, is warning about heat pump contractors who have taken or could take advantage of consumers.

CGC has found that many non-specialist contractors in both Canada and the United States have misrepresented their abilities and qualifications to design and install ground-source heat pump systems in the past three years. CGC-accredited professionals receive proper training and supervised field experience, have had their documentation checked, and agree in writing to follow the industry code of conduct. An arbitration mechanism exists within the national quality program, and CGC-accredited professionals may lose accreditation.

Accredited installers and/or designers should show a CGC Accreditation Identification Card bearing a number beginning with ACC-IN (for installers) or ACC-DE (for designers), which can then be checked against the CGC website's registry of accredited professionals. Any other identification, training certificate or 'accreditation' card issued by an international organization is not valid for the purpose of seeking CGC full system certification, as they are not adequate to satisfy program standards.

Federal and many provincial incentives require CGC System Certification.

CGC System Certification is the reliable way to be certain that the system is installed in compliance with ***CAN/CSA C-448-04 Design and Installation of Earth Energy Systems*** by reputable professionals.

CGC is issuing this warning because of ongoing industry concerns about shoddy workmanship by non-accredited installers. CGC runs the only comprehensive quality program in North America for this technology.

For more information:
http://www.geo-exchange.ca

The Technical Research Committee (TRC) is the industry's forum for the exchange of information on research and development in the housing sector.
Canadian Home Builders' Association, Suite 500, 150 Laurier Ave. West, Ottawa, Ont. K1P 5J4
Tel: (613) 230-3060
Fax: (613) 232-8214
e-mail: chba@chba.ca
www.chba.ca

LEEP: London Energy Efficiency Partnership

The construction industry puts serious responsibilities onto designers and builders. The buildings we build will be in use for a long time. The impact the buildings will have on the community and the environment are determined at the time of construction. The situation is made complex because, with perhaps the exception of factory-assembled modular buildings, every individual building is a unique prototype.

There is a strong push to improve the energy efficiency and to reduce the environmental impact of new buildings. However, innovation and improvements are made slowly in this industry because of the discomfort most designers and builders have about applying new technologies. There is a rightful concern about the use of inappropriate materials and technologies or unintended consequences.

Fortunately, today there is a better understanding of building science principles and more research, so that uncertain outcomes can be predicted if properly analyzed. However, there is still a hesitation on the part of practitioners to adopt new technologies that will result in a lower environmental impact, and more energy efficient buildings.

An initiative by the London Home Builders' Association in London, Ontario, in association with the City of London and Natural Resources Canada has developed an approach that helps builders select and apply energy innovations to their projects. It is known as the London Energy Efficiency Partnership, or LEEP.

The goals of LEEP were: to develop and demonstrate a process for identifying energy opportunities that recognizes local conditions and builds on local strengths; to produce and distribute a builder toolkit to help builders sort through technologies for subsequent implementation; and to introduce energy as a key component in community design by builders and city planners. The main focus was on energy.

The LEEP project has created a process that took into account a wide range of factors that are important to builders and their customers, and provides a balanced view on how new technologies are likely to perform. This allowed local builders to evaluate and make informed decisions on about 90 new technologies, and ultimately select the ones that will work best in the London area.

To be successful and get builder uptake, the process had to be builder-driven. One of the strong parts of the LEEP process was that builders participating in the process were willing to share their own ideas and expertise. Builders' involvement also meant the study did not lose sight of the added costs of green technologies that can affect both home price and builders' return.

The LEEP technology selection process involved compiling a list of more than 90 potential technologies with input from all stakeholders. With information and discussions, the builders sifted through the list and cut it down to the 34 technologies that most interested them. Then they decided on the selection criteria they wanted to use – it considered only new products with strong market pull potential. After establishing that, they looked at cost benefit, warranty and distribution issues. If a product received a green light in these areas, then its potential impact on builder sub-trades, schedules, available training and regulatory issues was examined.

The top 34 technologies were reviewed and a four-page evaluation data sheet on each technology was developed. Each was then reviewed and the list reduced to 17 energy-efficiency technologies. These were put into a toolkit that detailed the energy-efficiency technologies suitable for new or existing homes.

The kit offers builders and renovators who sign on to the program one-stop shopping for information on currently available energy-saving technologies ranging from solar water heating to structural insulated panels to drain water heat recovery. The kit's information sheets answer key questions about the technologies – what they are, who makes them, how they're installed and how they perform. This helps accelerate the technology-transfer cycle, as examples of activities and demonstrations that help spread information on the technologies were also identified.

Participating builders have already gone on to implement some of the technologies under discussion. Some of these include:

- ***Reid's Heritage Homes*** who are completing Canada's first LEED Platinum Project;
- ***Doug Tarry Homes*** who worked on the Solar Ready prototype, and incorporated advanced framing and zoned heating; and
- ***Rawlings Homes*** who incorporated several technologies into their latest EnviroHome.

R-2000
For information on the R-2000 Program, contact your local program office, or call
1-800-387-2000
www.R-2000.ca

The project partners plan to follow up and expand on the initial work with a database recording the experiences with installation and use of the technologies. The hope is that the London project will serve as a prototype for similar efforts across Canada.

LEEP Innovator Toolkit

The LEEP study began with a long initial list of technologies that was boiled down to 17. Some of these may be standard practice in some regions, not in others, so there will always be some regional differences. Some of the top builder choices in London included:

Advanced framing. This framing method makes optimum use of lumber and reduces wastage. Advanced framing also improves the insulation in exterior walls that will lower both heating and cooling requirements, and reduce energy bills for years.

Underfloor basement insulation: insulating the full basement floor.

Insulated Concrete Forms or ICF. Lightweight foam forms are used as forms during concrete placing and remain in place afterwards to serve as thermal insulation to produce a superior insulated wall. ICF houses tend to be more airtight and have better heat-retaining properties that will reduce the costs of heating and cooling. ICF systems can be used for basements or whole-house construction.

Structural insulated panels (SIP). These are foam panels sandwiched on either side of plywood or OSB skins. They offer superior insulating properties because there is little through-the-wall framing to introduce thermal bridging. SIPs can be used as structural elements in walls or roofs. SIPs are used for whole-house construction or just in some areas.

Drain water heat recovery. Drain water heat recovery systems can recover some or most of the heat from warm water that goes down the drain, such as during a shower. The warm water is used to preheat cold fresh water entering the water system. This is a simple, long-lasting technology that has no moving parts. The cold water coming into the house runs through a coil that is tightly wrapped around the drain stack.

Built-in high-efficiency lighting. A wide range of lighting fixtures now feature energy-saving technologies. These prevent the homeowner from replacing high performance lamps with low-efficiency incandescent lamps, which guarantees energy savings in the future.

Zoned air-handler combo heating system. Anyone who has experienced large temperature differences between different floors or areas a house will appreciate the impact of zoning heating and cooling systems. This has always been easy to do with hydronic systems, but not so with forced warm air heating systems. Zoned air-handler systems are now available that can provide multiple heating zones within the home, so the homeowner can independently control the temperature in different parts of the house to improve comfort and lower energy consumption.

Geothermal heat pumps use the natural heat storage ability of the earth for cooling and heating of houses and domestic hot water. Electricity is used to move the heat energy from one place to another.

Solar hot water heater

Integrated Mechanical Systems do the jobs of a furnace, air-conditioner, heat recovery ventilator and water heater in one appliance. With all components optimized to work together, these systems save energy and take up less space in the house.

Tankless Water Heaters use energy only when hot water is being used, eliminating the standby energy loss associated with storage tank water heaters. They conserve energy and take up less space in the house. Tankless water heaters can also provide homeowners with an endless supply of hot water.

The concept for the LEEP project originated at Natural Resources Canada's CANMET Energy Technology Centre (CETC). For more information on the LEEP Project:
Jamie Skimming, Air Quality Manager at the City of London. 519-661-2500 ext 5204 or e-mail: jskimmin@london. ca
London Home Builders Association: Lois Langdon 519-686-0343 ext 223 or e-mail: llangdon@lhba.on.ca.

LEEP templates are available for other local associations to undertake a similar exercise in their area.

CMHC EQuilibrium™ Demonstration Homes Now Open

EQuilibrium™ is a national housing initiative, led by CMHC, that brings the private and public sectors together to develop homes that combine resource and energy-efficient technologies in order to reduce their environmental impact. Twelve homebuilding teams were selected in 2007 to build EQuilibrium™ demonstration projects across Canada.

Since there were no successful projects in BC and Atlantic Canada in 2007, a second call was made in 2008 and successful projects were to be announced at the beginning of September, but the announcement has been delayed due to the federal election.

EQuilibrium™ housing integrates high-performance, energy-efficient passive solar design and commercially available on-site renewable energy systems such as solar water heating, electricity and ground-source heat. They are designed to produce as much energy annually as they consume. Connected to the electricity grid, these homes draw power only as needed, and can feed excess power back into the system.

EQuilibrium™ housing incorporates the principles of occupant health and comfort, affordability, resources conservation and reduced environmental impact.

The first projects have been completed and are now open for public tours. Information on each project is available on their web site.

ÉcoTerra™ – Alouette Homes
www.maisonalouette.com
ÉcoTerra™ is located at 9, rue de la Héronnière, Eastman, QC
For guided tours contact Mathieu Legendre at 819-820-9487.

Avalon Discovery 3 House
www.avalonmasterbuilder.com
Avalon Discovery 3 House is located at 3 Issard Close, Red Deer, Alberta.
The Avalon Discovery 3 House is open for public tours Monday to Wednesday from 2pm – 5pm, and Saturday and Sunday (and Holidays) from noon to 5pm.

Now House™
http://nowhouseproject.com
The Now House™ is located at 12 Topham Park, Toronto, Ontario.
For guided tours contact Lorraine Gauthier at 416.534.6609 or *lorraine@workworthdoing.com*

The Now House™ is a unique project, as it is a retrofit of a 1200 square foot, 1½ storey, 60-year-old WWII era house. The home is in a community of 200 similar homes. It was built in 1946 from plans prepared by CMHC.

Inspiration — The Minto Group
www.minto.com/ecohome
Inspiration is located at 5676 Manotick Main Street, Manotick, ON
For guided tours contact Lenard Hart at lhart@minto.com or at 416-850-8397

You Asked Us: About *Utility Shield* (Radiant Barriers)

We have received a quote for the installation of Utility Shield over the ceiling insulation in the attic. The supplier is claiming that it will reduce our energy costs, and pay for itself in 5 years. Is there any validity to the claims? Is it worth it for us to go ahead with this?

I believe that the product you are referring to is a 'radiant barrier' - this is a foil product that is supposed to reflect radiant energy and reduce energy use in the house. There are a number of manufacturers and distributors of such products. Unfortunately, there are also many unrealistic claims being made for them.

Radiant barrier products are often used in the southern US, where the climate is dominated by air conditioning (cooling) needs. Radiant barriers can have an impact on cooling loads, which is why they are used in the south. However, they have extremely limited potential to keep the heat in during the heating season.

There are several places that a radiant barrier can be installed. Most common ones are on top of attic insulation as you describe, or against the under side of the roof framing members (rafters) or underside of the top chords in a truss.

What the salesperson has recommended may be common because it is the easiest and, therefore, least expensive installation method, especially in a retrofit application. The problem with this method is that, over time, dust will settle on top of the foil barrier and reduce its effectiveness. Installing the barrier on top of the insulation also has the potential of trapping moisture migrating outward from the house in the insulation. Although the material may be perforated to allow moisture to escape, there is no information on the number of perforations necessary to keep from trapping moisture.

Most US energy experts feel that a radiant barrier can save between 5 percent and 15 percent on COOLING bills. If the monthly cooling bill is $200, the savings might be between $10 and $30. But this depends on the present ceiling insulation is, what the climatic conditions are, and where the house is located. If the attic insulation is quite thick, the effectiveness of the radiant barrier will be less.

Although the attic application of a radiant barrier might reduce some summer overheating, it will not have any impact on reducing the heating energy used. However, as you are located in Yorkton, Saskatchewan, you should be aware that there really is no cooling load there. Thus, anyone claiming that a radiant barrier installation at a cost of $2800 will be recovered in 5 years really doesn't know what he's talking about. Perhaps they should be challenged for making fraudulent claims.

Unfortunately, marketers of such products stretch the truth and rely heavily on anecdotal information and testimonials about the performance of their product. Such information lacks the scientific rigour to identify whether it was their specific product that is the source of the perceived benefits, or something else (unstated) done at the same time that had a possibly greater impact on the energy performance of the building. Another common tactic used is taking data from one type of application and extrapolating it to other applications where the conditions are totally different.

There is definitely a potential for saving on cooling bills by installing a radiant barrier, provided there is a cooling load in the first place. However, the effectiveness of the material depends on a number of factors, including the condition of the house, its design and location. Radiant barriers are not a substitute for a proper thermal insulation application in the first place.

If you are interested in upgrading your present older home, a starting point would be an **ecoEnergy** audit (formerly known as **Energuide**). The Energy Auditor will do a walk-through and measure the house, and do an energy analysis to identify energy performance upgrades that are both cost effective and that will provide real energy savings. At the moment there are a number of federal and provincial government incentives to help offset some of the costs - the amount depends on the specific upgrades done.☼

Energy Answers

Rob Dumont

I know that Canada is a laggard in the areas of energy efficiency and renewable energy. What are some of the more progressive countries doing?

In September 2008 I attended the Green Building Festival in Toronto. One of the lead speakers was Ronald Rovers of the Sustainable Building Support Centre in Holland. In his talk he surveyed some recently completed buildings and demo projects in Europe. The leading edge buildings and larger projects are very impressive. Even more impressive, however, were the national programs announced by several European governments. (That same week in September, the Canadian federal government announced it was lowering the excise task on diesel fuel, effectively encouraging more energy consumption and moving Canada further away from its Kyoto target. I felt myself slipping down in my seat in embarrassment as Mr. Rovers delivered his talk.)

Here are some of the European initiatives he mentioned:

- Britain has announced that by 2016 all new housing must be carbon neutral. In other words, net zero energy housing would be the norm for new construction.
- Sweden has announced that by 2020 it will be off petroleum completely. Energy conservation, biomass, district heating, and wind would be the key tools in achieving this.
- Norway has set a goal for all houses to be independent of oil and natural gas.
- Spain now has a standard that all new housing must use solar energy for domestic hot water.

A friend from Britain, David Olivier, recently e-mailed me that "in Austria, 8% of all new houses are being built to the Passivhaus (Passive House) energy efficiency standard," which essentially mean these houses will have zero space heating requirements.

Unlike Europe, Canada will not meet its Kyoto target. A 2007 Environment Canada report from the Canadian government projected that by 2012 Canada would be consuming 31% more energy than its Kyoto target.

The current Canadian government target is a 20% drop below 2006 levels by the year 2020. This "made-in-Canada" target essentially confirms that Canada will not meet its 2012 Kyoto target even by 2020, given that our current consumption levels are about 30% higher than the Kyoto target.

Most of the opposition to Kyoto focuses on the cost of implementing energy efficiency measures. Missed in most of the discussions is a realistic view of the cost of not acting on climate change. West Nile virus deaths, pine beetle infestations, reduced wild salmon stocks in the Canadian oceans, increased flooding of coastal areas - all of these are linked to climate change.

How much energy is used by buildings in Canada?

Here are the comparative numbers for various sectors of the economy from a 2007 document:

Secondary Energy Use in Canada (2004)	
Industrial	38%
Buildings	31%
Transportation	28%
Other	3%

Source: Council of Energy Ministers, Moving Forward on Energy Efficiency in Canada, 2007

According to the above ranking, buildings are the second highest consumers of energy in Canada. However, in part because of the shift from industrial jobs to service jobs taking place in Canada, the large building sector had the highest percentage growth in energy consumption of all the sectors over the period from 1990 to 2004. Large building energy use increased 35% over that time period, compared with 30% growth for industry.

A recent study for the American Institute of Architects entitled ***Architects and Climate Change*** estimates a much higher contribution from buildings to climate change. Their web site states that "Buildings account for half of all greenhouse gas emissions." The Canadian study mentioned above states that only 31% of secondary energy use could be attributed to buildings. The AIA study, however, also takes into account "the embodied energy of industry-produced building materials like carpet, tile, glass and concrete."

The AIA document calls for 100% of all new buildings to be carbon neutral by 2030, "meaning that the construction and operation of buildings will no longer require the consumption of fossil fuel energy or the emission of greenhouse gases.."

We now have in Canada a small number of net zero energy homes (CMHC's EQuilibrium Program) either completed or under way. Can we catch up to Britain and also have all of our new homes built to this standard by 2016? ☼

NRC-CNRC

NRC-IRC Building Science Insight Seminars, 2008/09

Single and multi-family houses: improving performance through a systems approach

The NRC Institute for Research in Construction is launching its 2008/09 ***Building Science Insight*** *series of one-day seminars. This year the seminars will demonstrate how ventilation and heating systems, high-performance windows, fire-resistant components, acoustic separations and liveable basements together can contribute to higher-performance low-rise buildings.*

Specific presentations are as follows:

Performing Basement Systems - Part 1: Managing the Water*

Proper site grading and foundation drainage are required in order to prevent water damage to basements and their contents. NRC-IRC researchers will review current construction practices for basements, examine why problems occur, and provide practical suggestions for improving drainage and construction.

Performing Basement Systems - Part 2: Managing Heat and Moisture*

The basement envelope is subjected to highly variable water and moisture loads. This session will examine emerging techniques and recommended approaches for managing moisture in wall assemblies for basements with living space.

*The two presentations on basements will not be given in Yellowknife, Whitehorse or Iqaluit.

Building Envelopes for Canada's Arctic Regions

This presentation will report the status and next steps of an NRC-IRC study to develop exterior wall systems that will perform effectively under the extreme conditions prevailing in the coldest and most remote parts of Canada. It will be given only in Yellowknife, Whitehorse and Iqaluit.

Sound Isolation in Wood-Frame Construction

Occupant satisfaction with the sound isolation between units is determined by the complex interaction of the separating wall or floor and all the building elements connected to those assemblies. This session will show designers how to choose elements that prevent significant structure-borne sound transmission from bypassing separating walls.

Fire Stops and Fire Blocks

To ensure good performance of complete building systems, designers and builders must use a systems approach that meshes the requirements for both sound and fire control. This presentation will address fire stops and fire blocks in the context of Canadian codes and standards, illustrate possible designs for fire stops at junctions and penetrations, and provide guidance on corresponding acoustical issues.

Infiltration, Ventilation and Indoor Air Quality in Canadian Residential Buildings

Infiltration and ventilation have a critical influence on indoor air quality and thermal comfort. This session will present an overview of the causes and effects of infiltration. It will then examine mechanisms to manage humidity efficiently and examine the effect of construction materials on indoor air quality. The presentation will conclude with a discussion of the possibilities presented by existing and emerging simulation technologies for improved design.

Canadian Centre for Housing Technology (CCHT)

More than 30 housing technologies have been assessed at CCHT's twin research houses. This presentation will present a brief overview of recent experiments and outline the main features of the CCHT facilities.

CCHT Case Study on Glazing, Part I - Field Study

In this presentation, researchers will describe a series of experiments conducted at CCHT to examine the impact of different window glazing technologies on energy consumption, room temperatures, window-surface temperatures, and the transmission of solar radiation.

CCHT Case Study on Glazing, Part II - Application and Practical Considerations

This presentation will explain how the results of the glazing experiments were used to refine

the HOT2000™ computer simulation tool, and will describe the energy performance of the two glazing systems studied, as well as that of a conventional double-glazed clear-glass system, for various Canadian climate zones.

All seminar registrants will receive copies of these recent NRC-IRC publications:

- *Guide for Sound Insulation in Wood Frame Construction*
- *Best Practice Guide for Fire Stops and Fire Blocks and their Impact on Sound Transmission*
- *Performance Guidelines for Basement Envelope Systems and Materials*

Registration information and other details are available at: *http://bsi.gc.ca*

English Seminars

- ❒ Yellowknife, Oct. 1, 2008
- ❒ Edmonton, Oct. 3, 2008
- ❒ Vancouver, Oct. 6, 2008
- ❒ Whitehorse, Oct. 8, 2008
- ❒ Toronto, Nov. 4, 2008
- ❒ Iqaluit, Nov. 6, 2008
- ❒ Winnipeg, Nov. 17, 2008
- ❒ Calgary, Nov. 19, 2008
- ❒ Saskatoon, Nov. 21, 2008
- ❒ St. John's, Dec. 2, 2008
- ❒ Halifax, Dec. 4, 2008
- ❒ Moncton, Jan. 13, 2009*
- ❒ Ottawa, Jan. 15, 2009*

French Seminars

- ❒ Quebec, Feb. 3, 2009
- ❒ Montreal, Feb. 5, 2009*

** With simultaneous translation*

Riverdale NetZero Project

The Riverdale Net Zero Project in Edmonton will officially open in October 2008.

This energy-efficient and environmentally responsible house will be the second Equilibrium™ house to open in Alberta. It was built in Edmonton by a team led by Habitat Studio and Workshop Ltd., Solnorth Engineering Ltd. and Howell Mayhew Engineering Inc., along with a team of 40 Edmonton-area experts.

The Riverdale NetZero Project is a side-by-side duplex that is designed to surpass the net zero energy goal. This was achieved by aggressively reducing energy consumption for space heating, water heating, lighting and appliances. An active solar thermal system should provide 64 per cent of the space heating and 93 per cent of the water heating. The grid-connected solar photovoltaic system provides all of the homes' electricity for lighting and appliances, as well as the remaining space and water heating.

According to Peter Amerongen, president of Habitat Studio, although the extra costs are not insignificant, from the extensive modeling done for this project and the practical lessons learned from building it, some of those costs should come down for the next net zero houses that they will be building.

Information: *www.riverdalenetzero.ca*

Sustainable EDGE Ltd.

Sustainable EDGE Ltd., an ecological design and green engineering practice in Toronto, extends the tradition of the 20-year partnership and expertise of Mario Kani and Greg Allen in multi-disciplinary sustainable design. Under the management of Mario Kani since early 2007, Sustainable EDGE has become involved in numerous green projects and technologies, such as a 100% renewable Living Building Challenge project, CHMC EQuilibrium houses project monitoring, a LEED Platinum high-rise condominium building, and a CMHC study on mould and fan efficiency in heating/cooling systems of multi-unit buildings.

Sustainable EDGE provides sustainable design by team collaboration of like-minded professionals. Through an integrated design process, they work with design teams to achieve a sustainable product that addresses Seven Principles of Sustainable Design. Sustainable EDGE also is conscious of serving a role for inspiration and training of the next generation of sustainable design professionals.

The focus is to expand the boundaries of sustainable design beyond merely reducing negative impacts. Their designs aim to enhance the health of occupants and their surrounding air, water, land, and communities, with a focus on simple and elegant integrated solutions. The final product is a sustainable project that is beneficial to the owner, users, the environment and future generations.

Information: Sustainable EDGE
www.s-edge.com

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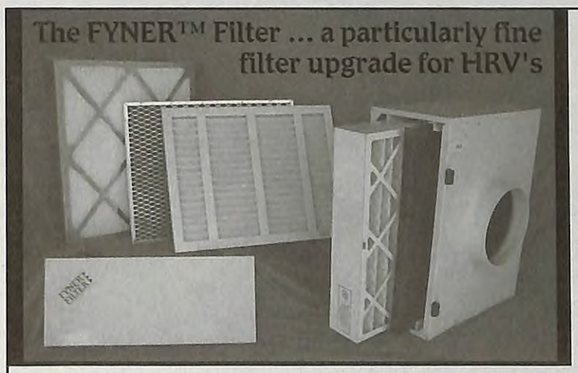

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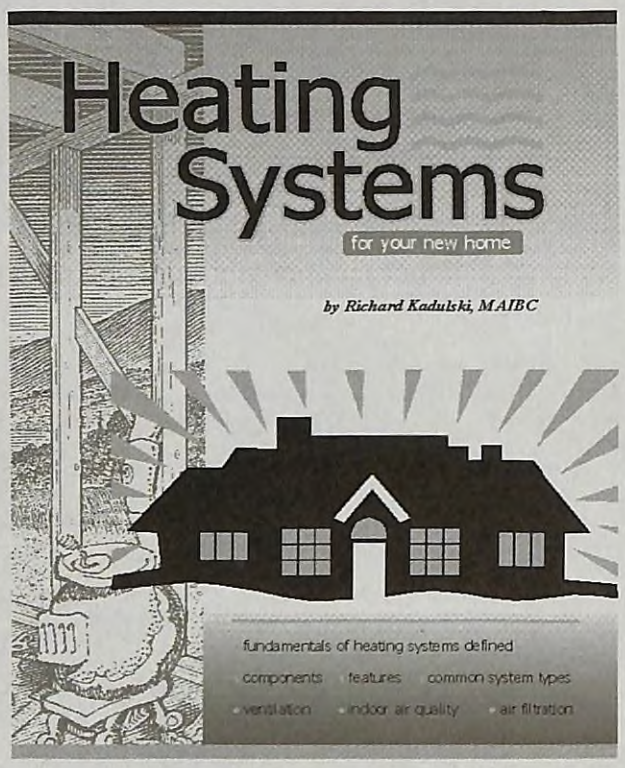
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